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GENETIC ANALYSIS FOR YIELD AND ITS COMPONENT TRAITS IN UPLAND COTTON (*GOSSYPIUM HIRSUTUM L.*)

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ABSTRACT

This study was undertaken to estimate the GCA of the parents and SCA of hybrids for development of high yield potential varieties. From 10 parents and 45 hybrids were obtained by crossing in a 10 x 10 half diallele design. Produced F_{1s} were sown in RCBD design. Analysis revealed that significant GCA and SCA effects for all the traits under study. Among the parents: GSHV 99/307 found to be good general combiners for seed cotton yield, Lint yield, Ginning out turn, Lint index, Plant height, number of monopodia per plant, Sympodial length at 50% plant height and number of reproductive points per plant. The high yielding hybrids were deducted with significant SCA effects for seed cotton yield and its component characteristics

KEYWORDS: Cotton, General (GCA) and Specific Combining Ability (SCA), Half Diallele Design Analysis, Seed Cotton Yield

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Original Article

INTRODUCTION

Cotton is natural fiber crop and plays a key role in the country economy, farmers mainly grown as cash crop due to immense importance to textile industry (Ashokkumar and Ravikesavan, 2011) and most important raw material provider for agricultural industries after sugarcane. Besides to, it generates an employment to about 60 million people in India (Kumar et al., 2014). The main objective of all cotton breeders is development of new varieties with high yield. To achieve this goal first step is the selection of appropriate parents for crossing by estimating combining ability. Combining ability analysis is a powerful tool to discriminate between good and poor general combiners and for choosing appropriate parental lines to produce hybrids having high yield potential coupled with reckon the gene action involved in the inheritance of characters.

Several breeding procedures have been established for genetic improvement of cotton populations and their hybrids. Half diallel design is most suitable method of crossing subjectively chosen parents. Several earlier studies on seed cotton yield and its related traits were determined by genes acting additively and non-additively. Ahuja and Dhayal (2007) suggested genes acting non-additively in contrary studies of Khan and Idris (1995) controlled that seed cotton yield, boll weight, number of bolls. Kumaresan *et al.* (1999) indicated both additive and non-additive gene effects were important for controlling of these traits.

The present investigation was undertaken to estimate GCA and SCA effects for seed cotton yield and its components traits for selection of suitable parents and hybrids.

MATERIALS AND METHODS

Plant Material

Ten G. *hirsutum* genotypes viz., GSHV 99/307, Pusa 9127, ARB 904, Surabhi, CCH 510, BS 277, BS 2170, H 1462, TSH 0250 and TCH 1728 were selected during 2010-11 based on superior performance in All India Coordinated Cotton Improvement Project (AICCIP) which are of diverse origin with stable in productivity across the cotton growing zone. During 2011-12 at ARS, Siruguppa, Forty five intra *hirsutum* hybrids were generated by crossing the parental genotypes in half diallel manner.

Field Evaluation

Seeds of F_1 hybrids and their parents were planted in the main field during *Kharif* 2013-14 with two replications in a randomized complete block design (RCBD). To maintain uniform plant population seeds were hand dibbled by accommodating 20 plants per each row with spacing of 60 cm within plant and 90 cm between the rows. All Recommended agronomic and need based plant protection measures were taken. Observations were recorded on the middle five competitive plants for the economic traits. The data were analyzed by using the WINDOSTAT advanced biometric statistical package, Indostat services, Hyderabad.

RESULTS AND DISCUSSIONS

Table 1: ANOVA for different Quantitative Traits in 10 x 10 Half Diallel Set of Cross at ARS Siruguppa during *Kharif* 2012-13

Source of Variation	DF	Seed Cotton Yield (kg/ha)	Lint Yield (kg/ha)	Boll Weight (g)	Ginning out Turn (%)	Seed Index (g)	Lint Index	Number of Bolls Per Plant	Plant Height (cm)	Sympodia per Plant
		1	2	3	4	5	6	7	8	9
Replicates	1	771.95	21364.45	0.01	4.94	0.46	0.04	11.72	722.94*	3.78
Treatments	54	4009.42**	63812.53**	0.42**	5.56**	1.40**	0.54**	26.51**	280.27**	29.72**
Parents	9	2493.78**	41296.70**	0.48**	3.52	0.86**	0.80**	20.19**	608.45**	23.77**
Hybrids	44	4406.85 **	69691.13**	0.41**	5.97**	1.54**	0.48**	28.33**	213.88	31.59**
Parent Vs Hybrids	1	163.23	7796.49	0.13	6.21	0.01	0.62	3.22	248.18	1.13
Error	54	446.23	7290.83	0.05	2.23	0.28	0.19	4.29	136.37	4.09
Total	109	2214.47	35421.52	0.23	3.91	0.84	0.36	15.37	213.05	16.79
GCA	9	4060.99**	68898.93**	0.26**	3.66**	0.99**	0.49**	22.67**	95.46	28.24**
SCA	45	1593.45**	24507.73**	0.20**	2.60**	0.64**	0.22**	11.37**	149.07**	12.18**
GCA/SCA		2.55	2.81	1.32	1.42	1.54	2.19	1.99	0.64	2.32
Error	54	223.11	3645.42	0.02	1.11	0.14	0.10	2.15	68.19	2.05

Table 2

Source of Variation	DF	Monopodia per Plant	Sympodial Length at 50% Plant Height	Number of Reproductive Parts per Plant
		10	11	12
Replicates	1	0.00	44.54*	0.10
Treatments	54	0.09**	118.48**	0.45*
Parents	9	0.10**	101.78**	0.17
Hybrids	44	0.09**	123.96**	0.51*
Parent Vs Hybrids	1	0.00	27.42	0.73
Error	54	0.02	8.90	0.27
Total	109	0.06	63.52	0.36
GCA	9	0.03*	142.38**	0.39**
SCA	45	0.04**	42.61**	0.20
GCA/SCA		0.61	3.34	1.97

Table 2: Contd.,				
Error	54	0.01	4.45	0.14

*, ** Significant at 5% and 1% levels, respectively

The analysis of variance for combining ability (Table 1) manifested significant differences between the treatments for all the traits under study suggesting the presence of substantial variability for the traits. Parents and crosses were also showed significant differences for all the traits. Nevertheless, both parents and hybrids differed significantly for all the characters except ginning out turn, number of reproductive parts per plant in parents, while Plant height in case of hybrids.

The proportion of mean sum of squares due to parents were greater than hybrids for Boll weight, Lint index, Plant height and Monopodia per plant whereas, it was *Vice versa* for other remaining traits. The mean sum of Squares due to Parent Vs Hybrids was non-significant for all the traits under study.

The *gca* variance was greater than *sca* variance for Seed cotton yield, Boll weight, Ginning out turn, Seed index, and Number of bolls Per plant (Patel *et al.*, 2009), number of monopdia per plant (Reza *et al.*, 2010), Sympodial length at 50% plant height, Number of Reproductive parts per plant indicating the predominance of additive gene action for these traits whereas, plant height **(**Reza *et al.*, 2010) were predominantly under control of Non-additive gene action as indicated by higher magnitude of *sca* variance than *gca* variance .

The general combining ability effects of the parents for seed cotton yield and its component characters are presented in Table 2. Among the parents GSHV 99/ 307 exhibited desirable and significant *gca* effects for seed cotton yield, Lint yield, Ginning out turn, Lint index, Plant height, number of monopodia per plant, Sympodial length at 50% plant height and number of Reproductive points per plant, whereas the parent Pusa 9127 recorded positive significant *gca* effects for Seed cotton yield, Lint yield, Boll weight, Seed index, number of monopodia per plant and Sympodial length at 50% plant height.

The parent ARB 904 recorded positive and significant *gca* effects for Ginning out turn, Lint index and Sympodial length at 50% plant height whereas the parent CCH 510 recorded positive and significant *gca* effects for Plant height, number of monopodia per plant, Sympodial length at 50% plant height.

Parent H 1462 showed positive and significant *gca* effects for Boll weight and Seed index, while the parents BS 277, BS 2170, TCH 1728 recorded positive and significant *gca* effects for Sympodia per plant, Boll weight and Seed index respectively.

Among the parents GSHV 99/307 found to be good general combiners for seed cotton yield, Lint yield, Ginning out turn, Lint index, Plant height, number of monopodia per plant, Sympodial length at 50% plant height and Number of Reproductive points per plant, while parent Pusa 9127 recorded positive significant *gca* effects for seed cotton yield, Lint yield, Boll weight, Seed index, number of monopodia per plant and Sympodial length at 50% plant height. The parents having higher *gca* effects for seed cotton yield and its component traits could be useful in yield improvement breeding programs by practicing early generation selections, since the *gca* effect was due to additive gene action and was fixable.

Table 3: Estimates of GCA Effects of different Quantitative Traits in 10 x 10 Half Diallel Set of Crosses

Parents (F_1 Crosses)	Seed Cotton Yield (kg/ha)	Lint Yield (kg/ha)	Boll Weight (g)	Ginning Out Turn (%)	Seed Index (g)	Lint Index	Number of Bolls Per Plant	Plant Height (cm)	Monopdia Per Plant
	1	2	3	4	5	6	7	8	9
GSHV 99/307	40.65**	173.43**	-0.17**	1.11**	-0.09	0.21*	1.42	2.56**	-0.02
Pusa 9127	15.28**	51.51**	0.12**	-0.33	0.34**	0.13	-3.28	0.74	0.02
ARB 904	4.3	26.89	-0.16**	0.83**	0.11	0.27**	3.13	0.66	-0.04
Surabhi	-6.07	-22.31	0.17**	0.06	-0.18	-0.09	-2.24	-0.02	0.07
CCH 510	4.38	16.14	0.01	0.02	-0.30**	-0.18*	-3.65	1.28**	0.04
BS 277	4.17	9.76	-0.08	-0.49	-0.25*	-0.25**	3.8	0.07	0.09**
BS 2170	-20.71**	-82.94**	0.15**	-0.46	0.03	-0.08	-0.57	-1.47**	-0.08**
H 1462	-11.07**	-50.56**	0.15**	-0.38	0.40**	0.13	0.38	-1.08**	0.01
TSH 0250	-19.79**	-76.69**	-0.18**	-0.29	-0.38**	-0.27**	3.25	-1.93**	-0.01
TCH 1728	-11.14**	-45.23**	-0.01	-0.04	0.32**	0.15	-2.24	-0.83*	-0.01
Parental mean	1215	445	4.39	36.56	9.67	5.6	115	14.5	1.2
$CD_{(gi)}$ @ 5 %	8.2	33.15	0.08	0.58	0.2	0.17	4.53	0.8	0.06
CD gi – gj @ 5%	12.23	49.42	0.12	0.86	0.3	0.25	6.76	1.2	0.09

*, ** Significant at 5% and 1% levels, respectively

Table 4

Parents (F_1 Crosses)	Sympodia per Plant	Sympodial Length at 50% Plant Height	Number of Reproductive Points per Plant
	10	11	12
GSHV 99/307	3.09**	6.50**	0.29**
Pusa 9127	1.40**	2.37**	0.13
ARB 904	0.3	1.33*	0.19
Surabhi	-0.30	0.70	-0.16
CCH 510	1.07**	2.45**	0.02
BS 277	0.14	0.37	-0.03
BS 2170	-1.37**	-4.62**	-0.24*
H 1462	-1.23**	-3.95**	-0.07
TSH 0250	-1.76**	-2.45**	-0.21*
TCH 1728	-1.33**	-2.70**	0.09
Parental mean	14.1	38	4.2
$CD_{(gi)}$ @ 5 %	0.79	1.16	0.2
CD gi – gj @ 5%	1.17	1.73	0.3

*, ** Significant at 5% and 1% levels, respectively

Table 5: Top Crosses Exhibiting Maximum sca effects, their Mean Performance and gca Status of Parents with Respect to Various Traits

Characters	Crosses	SCA	GCA of	
			Female	Male
Seed cotton yield	GSHV 99/307 x TCH 1728	65.07**	High	Low
	H 1462 x TCH 1728	62.87**	Low	Low
	BS 2170 x TSH 0250	57.36**	Low	Low
Lint yield	GSHV 99/307 x TCH 1728	293.38**	High	Low
	BS 1270 x TSH 0250	246.70**	Low	Low
	Surabhi x TSH 0250	205.37**	Low	Low
Boll weight	CCH 510 x TSH 0250	0.74**	low	Low
	H 1462 x TCH 1728	0.74**	Average	low
	GSHV 99/307 x TCH 1728	0.66**	Low	Low
Ginning outturn	GSHV 99/307 x BS 2170	3.28**	High	High
	BS 277 x TCH 1728	3.24**	Low	Low
	Surabhi x H 1462	2.45	Average	Low

Seed index	ARB 904 x CCH 510	1.32**	Average	Low
	CCH 510 x H 1462	1.30**	Low	Low
	H 1462 x TCH 1728	1.29**	High	High
Lint index	CCH 510 x BS 277	1.12**	Low	Low
	ARB 904 x TCH 1728	0.81	Average	Average
	ARB 904 x CCH 510	0.13	Average	Low
Plant height	BS 277 x TSH 0250	17.99	High	Low
	PUSA 9217 x TCH 1728	17.32	Low	Low
	H 1462 x TCH 1728	15.32	Average	Low
Monopodia per plant	Surabhi x TSH 0250	0.50 **	Low	Low
	BS 2170 x TSH 0250	0.42**	Low	Low
	PUSA 9127 x Surabhi	0.38**	Low	Low
Sympodia per plant	Surabhi x TSH 0250	6.27**	Low	Low
	GSHV 99/307 x TCH 1728	5.63**	High	Low
	BS 2170 x TSH 0250	5.16**	Low	Low
Sympodial length at 50% plant height	BS 2170 x TSH 0250	14.84**	Low	Low
	GSHV 99/307 x TCH 1728	11.30**	High	Low
	Surabhi x TSH 0250	10.05**	High	Low
Bolls per plant	ARB 904 x CCH 510	7.08**	High	Average
	GSHV 99/307 x TCH 1728	6.65**	High	Low
	H 1462 x TCH 1728	6.11**	Low	High
Number of reproductive points	PUSA 9217 x Surabhi	1.11 **	Average	Low
	GSHV 99/307 x PUSA 9127	1.04**	Average	Average
	Pusa 9127 x Surabhi	0.89**	Average	Low

The specific combining ability effects were estimated for all the 45 hybrids for 12 characters. Superior crosses with high *sca* effects and their GCA of both the parents are represented Table 3. With regard to seed cotton yield significant positive sca effects observed in 3 hybrids viz., GSHV 99/307 x TCH 1728, H 1462 x TCH 1728, BS 1270 x TSH 0250 involved parents were High x Low, Low x Low, Low x Low combiners respectively, indicating the presence of wide genetic diversity among the parents. For the trait Lint yield the cross GSHV 99/307 x TCH 1728, BS 1270 x TSH 0250, Surabhi x TSH 0250 exhibited significant positive sca effects where parents involved are High x Low, Low x Low, Low x Low combiners.

High *sca* effect in this combination might be due to possibility of interaction between positive alleles of good combiner with negative alleles of poor combiner. The crosses H 1462 x TCH 1728 (average x Low) were found to be best specific combiners for Boll weight. Presence of at least 1 parent with high *gca* effects indicating that a high general combiner in the cross combination might result in good specific combination.

For the trait Ginning outturn the only one cross GSHV 99/307 x BS 2170 (high x high) exhibited higher significant positive *sca* effect, whereas in case of Seed index cross ARB 904 x CCH 510 (Average x Low) exhibited higher significant positive *sca* effect. Even though very poor general combiners are observed for Lint index cross CCH 510 x BS 277 (Low x Low) produced a good hybrid combination with significant good *sca* effects which might be due to cancellation effects of its alleles.

Highest *sca* effects for Plant height, Monopodia per plant, Sympodia per plant, Sympodial length at 50% plant height, Bolls per plant, Number of reproductive points observed for the crosses BS 277 x TSH 0250 (High x Low), Surabhi x TSH 0250 (Low x Low), Surabhi x TSH 0250 (Low x Low), BS 2170 x TSH 0250 (Low x Low), ARB 904 x CCH 510 (High x Average), PUSA 9217 x Surabhi (Average x Low) respectively.

for seed cotton yield high *sca* effects were found due to high x high, high x average, high x low, average x high, average x average, average x low, low x high, low x average or low x low combining parents **(**Srinivas *et al*., 2014). The ideal specific combiner should have properties of high magnitude of *sca* effects in addition to high *gca* either in both or at least one of the parents is present. Average x average general combiners may forecasted to produce high yielding segregants in later generations because of High *sca* effects which can be used for selection of superior segregants (Bhatade *et al.* 1992). On other hand both good combiner expected to produce to segregants in the subsequent generations (Gururajan and Basu, 1992). However, parents with high x high *gca* effects were also reported by Narisireddy and Satyanarayana (2004).

CONCLUSIONS

The present investigation reveals *sca* effects and *per se* performances of the crosses were not closely related Which suggests that hybrids with high *per se* performance need not be the one with high *sca* effects. So the cross combinations may be selected either on the basis of *sca* or mean performance or in combination.

This study indicated that the parents GSHV 99/307, Pusa 9127 which had high *gca* effects for cotton seed yield can be utilized in crop improvement program. The crosses GSHV 99/307 x TCH 1728, H 1462 x TCH 1728, BS 2170 x TSH 0250 with high *sca* effects for cotton seed yield which can be exploited for hybrid vigor. Most of the yield traits were found to be controlled by additive gene action, therefore early generation selections may be appropriate for the improvement these traits in cotton.

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